EDITORIAL

FLUORIDE VERSUS SULFUR OXIDES IN AIR POLLUTION

For several decades, extensive investigations have been under way regarding airborne sulfur oxides and their effects on human health. Sulfur oxides are a major atmospheric contaminant derived from the burning of fossil fuels, particularly of soft coal.

In the two London, England, smoke disasters in 1940 and in 1952, sulfur oxides received understandably much attention because the smoke could be seen coming out of the many chimneys of London homes where soft coal was being burned. Furthermore, their characteristic odor, their bluish-white color, and the relative ease of demonstrating their presence in the air accounted for their identification with coal smoke. Nevertheless, some investigators (1-3) questioned the role of sulfur oxides in smoke disasters, because the officially reported concentrations in the air were not sufficiently elevated to induce serious damage to health. In the 1952 London disaster, the average concentration of sulfur dioxide was 1.7 ppm which is well within the industrial threshold limit of 5 ppm (4).

In contrast to the London disaster, in the Donora, Pennsylvania (1948), and the Meuse Valley (1930) pollution episodes, where zinc smelters and fertilizer plants contributed significantly to the atmospheric contamination, sulfur oxides played a minor role. These industries are notorious sources for fluoride emission. Indeed, the official investigators failed to establish a major contaminant to which the disastrous effect could have been attributed since knowledge on airborne fluorides was very sparse at that time. Independent studies in both areas, in Donora by Sadtler (5) and in the Meuse Valley in retrospect by Roholm (6) produced considerable evidence indicating that fluoride was primarily responsible for illness and death in these two disasters.

In reviewing the effects of the two pollutants on vegetation and domestic animals there can be no doubt that airborne fluoride is far more harmful than sulfur oxides. Guinea pigs exposed to sulfur oxides continuously for one year at a concentration of 5 ppm failed to develop respiratory disorders (7). Fluoride, on the other hand, reaches the blood stream both through inhalation and by ingestion with contaminated food. Similarly, in plants the translocation of fluoride throughout the plant structure and its damaging effect on leaves, blossoms and fruit is much more pronounced than that of sulfur oxides (8). In comparing the effects of sulfur oxides on plants with that of fluorides, Bohne (9) showed that greater amounts of fluoride had accumulated and that fluoride had caused more damage than sulfur oxides.

In humans, more than 90% of inhaled sulfur oxides are absorbed in the airways above the larynx (10). With the moisture of the air, they form sulfuric acid and sulfates which, although irritating to the respiratory membranes, are of low toxicity.

Thus sulfur oxides irritate, primarily, the upper respiratory tract. They rarely, if ever, enter the distal portions of the lungs and the alveolar system. They never enter the blood stream. Fluoride,on the other hand - a systemic poison - is promptly absorbed into the blood stream from the upper respiratory tract. It affects primarily the calcified tissue but can also induce considerable damage to many other organs, especially the arteries and the heart.

In the London episode, the delayed effects and subsequent deaths from respiratory diseases differed materially from effects in Donora and in the Meuse Valley where heart failure played a major role in the afflicted persons. Sulfur compounds are associated with a general increase in the total white male mortalities (11). These authors were not aware that sulfur oxides are not likely to reach beyond the respiratory tract. The simultaneous presence of fluoride and other toxic agents in coal and other fossil fuel could well account for their findings.

Recent studies by Dässler and others (see page 223), from the German Democratic Republic, tend to shed considerable light on the explanation of the cause of casualties in the London disaster. They found that the fluoride content of soft coal may reach a level as high as 1400 ppm (ashed) and that between 70 and 100 percent of gaseous fluoride is airborne when coal is burned. In other words, where there is smoke from burning coal there is also fluoride. Thus, the systemic damage to humans believed to have been induced by sulfur oxides is likely to be primarily brought on by fluoride in conjunction with such other toxic agents as arsenic, cadmium and mercury present in coal (4). Further studies on this problem are indicated.

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